

## RADIAL PISTON PUMP

[0001] Prior Art

[0002] The invention relates to a radial piston pump for generating high fuel pressure in fuel injection systems of internal combustion engines, in particular in a common rail injection system, having a driveshaft, supported in a housing, that has an eccentrically embodied shaft portion which cooperates with preferably a plurality of pistons capable of reciprocating radially, relative to the driveshaft, in a respective element bore, in order to aspirate fuel and subject it to high pressure in a high- pressure region.

[0003] A radial piston pump of this generic type is known from German Patent Disclosure DE 198 47 044 A1. In the known radial piston pump, an annular groove which communicates with a plurality of axially disposed conduits is made in the outer jacket face of the pistons in the circumferential direction. The macroscopic conduits serve to orient the pistons "hydraulically", each in the associated element bore.

[0004] The running paths of the pistons and of the element bores must on the one hand be very smooth and have a uniform surface. On the other hand, a certain quantity of the medium to be compressed should adhere as lubricant to the surfaces, which dictates a certain surface roughness. This roughness subtracts from the load-bearing portion of the surface; that is, the full jacket face of the pistons and of the element bores cannot be effectively utilized as a running path. The surface roughness also limits the accuracy of shape and dimension to be attained. This limitation means that certain minimum plays cannot be undershot, which in turn lowers the efficiency of the radial piston pump. This effect is all the more pronounced, the higher the pressure in the radial piston pump becomes.

[0005] It is the object of the invention to increase the efficiency and lengthen the service life of the known radial piston pump.

[0006] In a radial piston pump for generating high fuel pressure in fuel injection systems of internal combustion engines, in particular in a common rail injection system, having a driveshaft, supported in a housing, that has an eccentrically embodied shaft portion which cooperates with preferably a plurality of pistons capable of reciprocating radially, relative to the driveshaft, in a respective element bore, in order to aspirate fuel and subject it to high pressure in a high-pressure region, this object is attained in that in the outer jacket face of the pistons and/or the inner jacket face of the element bore, a structure in the  $\mu\text{m}$  range is formed.

#### [0007] Advantages of the Invention

[0008] The running paths formed on the piston jacket face and in the element bore can, in the radial piston pump of the invention, be embodied very smoothly and accurately in terms of shape. As a result, very small plays are attainable, which especially at high pressures, because the gap losses are so slight, leads to good efficiency of the radial piston pump. The smooth surfaces would, however, hinder adequate lubrication in operation of the radial piston pump and would cause the pistons to seize. The targeted structuring of the surface of the pistons and/or of the element bores has the function of lubricant pockets and lubrication conduits. The structuring can be made in a targeted way, for instance with the aid of a laser. Via the structure made in the surface, the lubricant medium is distributed during operation to the lubrication points to be supplied along the running paths. At the same time, the structuring acts as a reservoir for the lubricant medium.

[0009] One particular embodiment of the invention is characterized in that the structure is embodied such that in operation there is no direct communication between the high-pressure region, defined by one face end of the respective piston, and a low-pressure region, defined by the other face end. As a result, leakage flows and gap losses are kept as slight as possible.

[0010] A further particular embodiment of the invention is characterized in that the structure is formed by lubrication conduits, which extend substantially in the circumferential direction. By this means, it is attained in a simple way that there is no communication between the low-pressure region and the high-pressure region. The size of the storage reservoir for the lubricant medium can be defined by way of the number of lubrication conduits.

[0011] Another particular embodiment of the invention is characterized in that the structure is formed by lubrication conduits, disposed in pairs, each of a different length, which each have arms oriented perpendicular to one another, with one arm disposed in the axial direction and the other arm in the circumferential direction of the respective jacket face. As a result, especially good distribution of the lubricant over the surface to be lubricated is achieved.

[0012] Another particular embodiment of the invention is characterized in that the structure is formed by many axially extending conduits, which are disposed in groups and which communicate with one another through conduits extending circumferentially. In this type of in-line connection, the flow resistance in the axial direction can be varied

by way of the number of conduits extending axially. By means of additional connecting conduits in the circumferential direction, the lubrication in certain regions can be improved in a targeted way. The flow resistance is furthermore dependent, among other factors, on the parameters of conduit shape, conduit cross section and conduit length. By a suitable choice of these parameters, the supply of lubricant can be designed to suit what is needed.

[0013] Drawing

[0014] Shown in the drawing are:

[0015] Fig. 1, the developed view of a jacket face of a piston in a first embodiment of the invention;

[0016] Fig. 2, a perspective sectional view of an element bore of the invention;

[0017] Fig. 3, a portion of the developed view of a piston jacket face in a second embodiment of the invention; and

[0018] Fig. 4, a portion of the developed view of a piston jacket face in a third embodiment of the invention.

[0019] Description of the Exemplary Embodiments

[0020] The radial piston pump of the invention is used in particular in common rail injection systems to supply Diesel engines. The term "common rail" means the same as common line. In contrast to conventional high-pressure injection systems, in which the fuel is supplied to the individual combustion chambers via separate lines, the injection nozzles in common rail injection systems are supplied from a common line.

[0021] One such radial piston pump is shown in Figs. 4-6 of DE 198 47 044 A1, for instance. The radial piston pump shown there includes a driveshaft, supported in a pump housing and having an eccentrically embodied shaft portion. A ring is provided on the eccentric shaft portion, and the eccentric shaft portion is rotatable relative to this ring. The ring includes three flat faces, offset from one another by  $120^\circ$  each, and one piston is braced on each of these faces. The pistons are each received in an element bore in a way capable of reciprocating radially to the driveshaft, and they each define one cylinder chamber.

[0022] At the foot of each piston, a plate which rests on the associated flat face of the ring is mounted by means of a plate holder. The plate holder is secured to the piston by a snap ring. The radial piston pump serves to subject fuel, which is furnished from a tank by a prefeed pump, to high pressure. The fuel is preferably Diesel fuel. The Diesel fuel subjected to high pressure is then pumped into the aforementioned common line.

[0023] In the supply stroke, the pistons are moved away from the axis of the driveshaft as a consequence of the eccentric motion of the ring. In the intake stroke, the pistons move radially toward the axis of the driveshaft, in order to aspirate fuel into the cylinder chambers. The intake stroke motion of the pistons is attained by means of a spring, which is prestressed against the plate holder or the plate.

[0024] In Fig. 1, a developed view is seen of the jacket face of a piston of a radial piston pump of the invention. Reference numeral 1 indicates the high-pressure region and reference numeral 2 the low-pressure region of the radial piston pump. The developed view of the piston jacket face is identified overall by reference numeral 3. In the piston jacket face, a plurality of lubrication conduits 4, 5, 6, 7 and 8 extending in the circumferential direction are disposed parallel to one another. Toward the high-pressure region 1, the lubrication conduits are spaced closer together than toward the low-pressure region 2. The individual lubrication conduits do not communicate with one another and in practical terms are connected parallel.

[0025] Fig. 2 is a perspective view of an element bore 20 in section. On the inner circumferential face of the element bore 20, there are a plurality of lubrication conduits 4, 5, 6, 7 and 8 extending in the circumferential direction.

[0026] In Fig. 3, a developed view of the jacket face of a piston in a further embodiment of the invention is shown. In the embodiment shown in Fig. 3, ten lubrication conduits 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18 each are combined into one group. The lubrication conduits 9-18 are L-shaped. One leg of an L-shaped lubrication conduit is

disposed in the circumferential direction, while the other leg is disposed in the axial direction. Two lubrication conduits at a time, with legs of equal length axially, are disposed in pairs with one another in such a way that the legs in the circumferential direction face toward one another.

[0027] In the embodiment shown in Fig. 4, a T-shaped lubrication conduit 24 is disposed in the vicinity of the high-pressure region 1. The center axis of the T-shaped lubrication conduit is oriented toward the high-pressure region 1. The T-shaped lubrication conduit 24 is surrounded by two L-shaped lubrication conduits 25 and 26. From the circumferentially disposed legs of the L-shaped lubrication conduits 25 and 26, a plurality of lubrication conduits 27 extend axially. The axially extending lubrication conduits 27 are intersected by a plurality of lubrication conduits extending circumferentially. In Fig. 4, one of these circumferentially extending lubrication conduits is marked as an example with reference numeral 28. From the lubrication conduits extending circumferentially, in turn a plurality of axially extending lubrication conduits originate, of which one is shown as an example at 29 in Fig. 4. Adjoining these axially extending lubrication conduits in turn are circumferentially extending lubrication conduits 30. These are followed by lubrication conduits 31 oriented axially and lubrication conduits 32 oriented circumferentially.

[0028] The lubrication conduits made by means of lasers are not continuous in the axial direction. The lubrication conduits are interrupted, in order to keep the gap losses and leakage flows as slight as possible. The lubrication conduits can form regular patterns, as shown in Figs. 3 and 4, or can be disposed irregularly.